Cross Cascades Corridor Analysis Project

Technical Memorandum No. 2
Travel Time Reliability

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for the
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Reliability of travel can be as important as travel speed itself. Travelers make plans based on expected travel times. Shippers use "just in time" delivery techniques requiring accurate prediction of delivery times.

The Washington Transportation Plan (WTP) Outcomes and Service Objectives for "Enhanced Mobility: Congestion Relief" recognize this relationship by defining a service objective for reliability as well as for reduced person and freight delay and improved travel times. The purpose of this paper is to suggest a more precise and measurable definition of reliability and describe how reliability could be used as a performance measure in transportation and traffic modeling.

Definition

The essence of travel time reliability is the ability to predict outcomes of travel decisions. This is different from predicting the on-time performance of travel. If travelers or shippers can accurately predict the amount of delay for a certain trip or shipment they may plan accordingly. The users of the highway system normally take account of morning and peak congestion, planning their trips by either accounting for the extra travel time required or choosing another time of day to travel.

WSDOT's Travel Delay Methodology as currently constructed predicts delays due to traffic congestion, but does not predict the effect of other more random events such as delays due to accidents or weather conditions. The method of predicting delays used in the travel delay methodology is to compare capacity with traffic volumes. As the volume of traffic approaches capacity the roadway becomes "saturated" and traffic must slow. The behavior is so predictable that the TRB *Highway Capacity Manual*[1] contains tables and formulas to predict actual speed based on design speed, capacity and volume. These formulas are used in the Travel Delay Methodology to predict system performance and to measure the impact to motorists in terms of time loss and increased vehicle operating costs.

[1] *Highway Capacity Manual*, Special Report 209, Third Edition, Transportation Research Board, National Research Council, Washington, DC, 1994

By comparison to existing measures of travel delay, the following definition of travel time reliability is proposed:

> *Travel time reliability is the absence of delay not predicted by the Travel Delay Methodology. A measure of reliability must relate to the amount of delay not predicted by the Travel Delay Methodology or other models of performance based on congestion and capacity.*

Reliability as a Performance Measure

An accurate reliability measure would track actual travel times compared to predicted or average travel times. For roads, the measure could represent the amount of increased travel time required from the predicted time, based on the Travel Delay Methodology or from average time as actually measured. The cost of these delays could be calculated in the same way as for congestion-induced or other predicted delays.

Obtaining data is a key issue in implementing performance measures. In the case of developing a reliability measure, there are three potential ways to complete these measurements:

1. Direct measure by collecting real-time information on highway speeds.

   This could be done by monitoring traffic through use of monitoring technology such as the loop detectors used in the Puget Sound area, or the automated vehicle identification (AVI) technology as in Spokane. (Technical Memorandum No. 1 describes how such a system could be set up statewide.) By comparing actual speed data to average or predicted speeds, incidents that disrupted traffic flow could be identified and measured in terms of their duration and impact on actual speeds. By correlating the information with traffic volumes an estimate of reliability related delay hours could be calculated.

   A potential drawback of this method is that speed monitoring through these technologies does not identify what occurs between measurement points. As a result, in order to use the delay information in setting operational or policy priorities, additional analysis would have to be conducted to identify the source of delays. Outside of urban areas, a high percentage data sample or additional information would be required to distinguish between delays and motorists deciding to stop en route for other reasons.

2. Sample measures in which speed was monitored on road segments for specified periods of time.

   In the absence of real-time data, a sampling process could be worked out to estimate how often delays occurred. This would provide a measure for the overall system, but may not be as useful as a direct measure for understanding exactly where the problems are occurring.

3. Tracking the causes of non-predicable travel disruptions.

   There are three predominant causes of unpredicted delays: traffic incidents including accidents and vehicle stalls; weather and other natural phenomena; and maintenance and construction activities. Currently, the data that's been collected is not entirely adequate to determine the amount of delay, but could be adjusted to provide better information. The best use of this data would be as a supplement to directly-measured delay to determine causes. By itself, the data will likely not be sufficient to determine the amount of delay resulting from each incident.

Reliability in Modeling

Travel time reliability is not typically addressed in transportation models, and unfortunately, there are no generally accepted practices for estimation of reliability in forecast models. The "reliability factor" used in the Travel Delay Methodology is, in fact, an average delay factor calculated from volume and capacity data. Likewise, travel delay as reported by Texas Transportation Institute uses modeled relationships between volume and capacity to determine delay. Modeling of travel time reliability would require specification of location, time and severely of irregular delays. It would then require information about how activity on the system reacts to the delays.

Little information exists on driver and traveler reaction to delays. A stated preference survey would be one way to get at this data, but thus far it has not been used in this way. A better way to gather the data would be through origin-destination surveys tied to specific incidents. This could be achieved through "revealed preference" surveys that ask, "What did you do when . . ." rather than, "What would you do if . . ." Finally, some research is already underway in cooperation with the TRAC (University of Washington Transportation Research Council) to determine how traffic volumes change in response to notification about incidents. This will provide useful information about driver reactions for use in future models.

A more realistic means of producing a measure of reliability for the Cross Cascades Corridor model might be to build an external equation/estimate that could be used post-process. Initially, it would rely on the data that's available to WSDOT on weather and accident related incidents. This would estimate the delays that occurred for use in understanding how the system would perform. Unless data on travel choices with delayed conditions were available, it would not be possible to predict changes in traffic patterns resulting from travel speed reliability issues.

In the long term, micro-simulation models now being developed will have the capability of modeling irregular delays by introducing random incidents. Correctly determining traveler reactions would still be an issue.

Reacting to Reliability Issues

A travel time reliability measure would provide a baseline point from which to measure progress in improving the performance and function of Washington's transportation system. There are three alternative methods for reducing the impact of reliability issues:

1. Reducing the number of incidents.
2. Reducing the effect of incidents by more quickly restoring travel to normal conditions.
3. Informing travelers about congestion and random events so they can adjust to the situation.

Currently, WSDOT is actively pursuing all three methods. Safety and information systems attempt to reduce the number of vehicle crashes. Maintenance and construction activities are increasingly conscious of minimizing impacts on travelers. Incident response systems attempt to more quickly restore traffic flows when incidents do occur. With regard to snow and ice removal, a new WSDOT initiative seeks to measure and reduce the time required to return pavements to clear conditions after snowfall. Traveler information systems are being expanded in both urban areas where better, more timely reporting of incidents can allow travelers to exercise options, and in rural areas where information on mountain pass closures and weather conditions can help travelers either avoid delays or be prepared for areas where delays may occur. Construction reports on WSDOT's website allow travelers to plan for or avoid construction delays.

To the extent that a travel time reliability measure contains information on the number of vehicles impacted and the time involved in a delay condition, it can account for actions that restore service or provide information to allow travelers to avoid incidents, as well as measures to prevent incidents.

For example, during the 2000-2001 winter season, Snoqualmie Pass was closed a total of 64 hours due to six incidents involving inclement weather, maintenance, rerouting of oversized loads, and a vehicle fire. Knowledge of the traffic volumes involved would provide needed information on the economic impact of these delay events. Moreover, some of the maintenance involved in avalanche control to prevent further incidents and publication of weather conditions and planned maintenance probably reduced the number of travelers affected by these conditions.

Existing Data

WSDOT is already collecting some data relevant to travel reliability, including:

- Travel speed and volume data collected in the Puget Sound area by use of loop detectors;
- Data on urban incidents in the Puget Sound area based on incident response requests;
- Traffic accident data throughout the state can be used to identify where incidents occur, although they do not contain information on lane or road closures;
- Speed data in the Spokane area based on AVI; and
- Pass closure data on Snoqualmie and Stevens passes.

Conclusion

In the Seattle and Spokane areas, it would be feasible to develop a travel delay measure based on data that is already being collected. In other areas of the state, such a measure will require new information based either on additional traffic monitoring or other additional traffic information associated with existing incident data. Such a measure would provide a baseline point from which the state can measure improvement in reducing traffic incidents and other non-predicted traffic delays. While existing models do not directly predict travel time reliability disruptions as defined here, data from these models could be used in conjunction with other traffic delay data to better predict the distribution and impacts of incidents that disrupt traffic flows and travel times.